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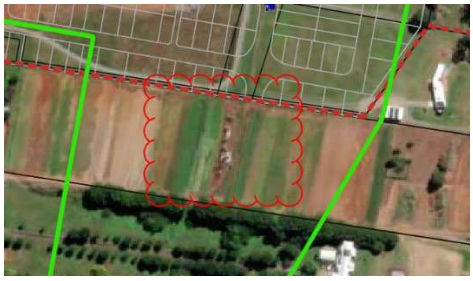
Technical Memo

To:	James Langston
From:	Daniel Esposito, Kelly McKendry
Project Name:	401 Rochedale Road - Response to Flooding Issues
Date:	28 April 2023
Our Reference:	20-0102TM-V2

1. Response to Information Request

Responses to the items raised from BCC (reference to the correspondence on 22nd of March, 2023) have been captured below.

Item	Response
Provide modelled pipe flows in the 2D model in Ford Road and Rochedale Road and Ult1 for the 10% AEP event for ultimate conditions (can just add them to Table 3-2)	Table 2-2 (Interim Developed Scenario) and Table 3-2 have been updated to include the 10% AEP flows for the 60 min storm event (critical storm event) across the primary stormwater pipes (connector pipes have been omitted from the assessment).
Provide what flow is conveyed in the interim scenario in the temp channel within 361 Rochedale Rd and its low flow pipe in each event.	Table 3-3 reports the flow conveyed in the interim developed scenario in the temporary drainage channel within 361 Rochedale Road and the low flow (600 mm RCP pipe) for all assessed storm events.
Need to show that the low flow 600mm RCP can actually drain to existing levels within 361 Rochedale Road (e.g. if tail-out required it must be on that land).	For the interim scenario, channel works (excavation) is required at the outlet of the 600 mm RCP pipe invert level - this allows the outlet of the pipe to tie in with the surface of the drainage corridor. The invert level of pipe outlet is assumed 60.0 m AHD. See Drawing 20-0220-SK04 in Appendix B.
There is no flooding being shown on the property to the South of Pinnacle. While for [the] ultimate it's not an issue, in the interim scenario it is	The model has been modified to include inflows upstream of the southern boundary of Pinnacle. The modelling has determined a minimum fill level

because it may influence the flood immunity of lots along that Southern Boundary and the pit inlet needs to be modelled in the interim scenario. 	over lots 146 to 149 and 150 (The Pinnacle at Arise Stage 8) to ensure immunity and is provided in Section 3.3.7.3. The pad levels of lots 146 – 149 of Pinnacle are to be raised above the predicted 1% AEP flood levels to maintain flood immunity. Overland flow is to be directed toward the road, with minor flows (up to and including the 10% AEP event) to be collected by the pit inlet, with the difference of flows to be routed via kerb and channel north. The TUFLOW model includes a custom inlet curve at this location which has a maximum capacity of 4.0392 cumecs above 0.3 m depth. Suitable inlet arrangements will be determined on detailed design. Refer to Section 3.3.7.3.
Describe what's going on along the Nth boundary of 361 Rochedale Road as a lot of water is going that way (assume it's a boundary condition) and the model boundary might need to be extend further north? While it's not part of the application I'm concern if water is escaping from the model that should be heading south, or the boundary condition might be generating water that moves back to Rochedale Road?  	The model boundary has been extended further north across all modelled scenarios (E07, P05c, U10, U10ss). The model boundary is deemed of sufficient distance from the area of assessment, and does not influence water levels within the proposed temporary swale along the southern boundary of 361 Rochedale Road. Sheet flow is predicted to occur along the northern boundary of 361 Rochedale Road, with a reduction in flow depths predicted, relative to what was previously reported (model boundary not extended). Flows along the northern boundary are to be handled as part of a separate application. It is anticipated that an access road is to be built along the northern boundary of 361 Rochedale Road. This will allow flows to be adequately conveyed to the drainage corridor. If construction of 361 Rochedale Road proceeds the development of the access road, then a temporary easement / pipe will be required to collect and convey flow from Rochedale Road to the drainage channel as a viable temporary solution to manage flows along the northern boundary.
The ultimate model (or lets say another version of it) needs to fill the area shown below, because future filling will divert more water down Ford and Rochedale Roads and this may impact flood	Another version of the ultimate scenario was developed to inform the flood immunity and trafficability along Rochedale and Ford Road. The

immunity at 401 Rochedale Road. No need for flood impact assessments, just need this scenario to check flood immunity of 401 Rochedale Road lots along that road frontage and the Southern boundary channel on that development.  	modelling indicated that Rochedale and Ford Road are considered trafficable in accordance with QUDM, and the lots encompassing the road boundary are deemed immune to flooding. Refer to of the report below.
The channel along the southern boundary of 401 Rochedale Road terminates at a road where the road/verge level is approx. 65.8m AHD. Lot 103 is only at 65.8m AHD and so if the inlet in this channel blocks (or in extreme rainfall events) this lot will flood, and the blockage will create a backwater up the channel so all lots would be impacted along the Southern boundary. Therefore, the minimum fill level for any lot along that southern boundary channel is to be 66.1m AHD requiring lots 103 to 109 to be raised between 300mm to 100mm.	Amended. Attachment B contains a revised set of engineering drawings.
The proposed trunk pipe near the surcharge location would need to be revised so that the ultimate trunk pipe will not form an acute angle (e.g. 90deg bend) and the stormwater will connect to the existing drainage culverts at Rochedale Road.	Amended. Attachment B contains a revised set of engineering drawings. This is a temporary drainage solution, with the ultimate trunk line (outlined in pink) to replace the surcharge pit and temporary structures (outlined in orange).
Need more details on minor flow diversion from 401 Rochedale Road (e.g. what flow and does existing pipes have the capacity for those flows) to demonstrate a LPD is suitable.	Minor flow diversion conveys 100 L/s - this is in line with the flows reported in the corresponding technical memo (stormwater strategy) for 401 Rochedale Road (18-0150TM01-V1). There is capacity in the adjoining SW network to convey the minor flows from the basin, and serves as a LPD.

2. Introduction

2.1. Basis of Assessment

An information request was received from Brisbane City Council (BCC, Development Application ref: A005559232). Noting the following clarification and/or additional information was required:

- *A 2D flood model is now required to demonstrate flood immunity and flood impacts. The 2D model is to model the upslope areas and is to include an earthworks TIN of the proposed developments, the proposed channel along the southern boundary of 401 Rochedale Road, and the outlet pipes to the north, demonstrating compliance of flood immunity requirements.*
- *The upslope developments, owned by PASK, that are to be considered as part of this assessment:*
    - *401 Rochedale Road (Arise Stage 8 -11) / A005559232*
    - *546 Rochedale Road (Pinnacle) / A005910927*
    - *487 Rochedale Road / A005958748*
    - *361 Rochedale Road*

This technical memorandum outlines the methodology to assess the viability of the proposed development scenarios – Interim Developed Case (P05) and Ultimate Developed Case (U10) – and the impact that each will have on the flow behaviour throughout the catchment. The document should be read in conjunction with the Flooding and Stormwater Management Plan submitted undertaken as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (FSMP) (20-102FSMP01-V3), contained in **Attachment A**.

2.2. Development Scenarios

The following development scenarios have been assessed to the consider construction sequencing and stormwater management options, to demonstrate impacts are mitigated:

Base Case Scenario: This scenario adopts the hydrological and hydraulic modelling outputs from the Base Case Scenario (E07) of the Pinnacle at Arise Flooding and Stormwater Management Plan (FSMP) (20-102FSMP01-V3). No changes have been undertaken to this scenario, with the results from this assessment to be considered as part of this investigation.

Interim Developed Scenario: This scenario assumes the PASK owned sites within the catchment are developed. The scenario is intended to demonstrate the proposed developments can proceed without the construction of the section of trunk infrastructure from Rochedale Road to the waterway outlet. The proposed interim stormwater arrangement includes:

- Trunk connection along Rochedale Road (with final section a 2.4 m RCP terminating in Rochedale Road)
- Interim connection to a surcharge pit, located within private land under the control of PASK.
- Minor flows from the surcharge pit are to be conveyed via a 600 mm RCP (bleeder pipe), with the balance of the flows (major) to be routed via a temporary easement to discharge into the drainage corridor (mapped waterway).
- The proposed stormwater measures specific to each PASK site (including interim measures within Arise Stages 8-11, 401 Rochedale Road).
- Formalisation of roadside channels along Ford Road and Rochedale Road to improve immunity and maintain flow within Ford Road.

Ultimate Developed Scenario: The scenario assumes an entirely developed catchment, with the trunk connection along Rochedale Road extended to the drainage corridor (with the surcharge pit and bleeder pipe decommissioned). A sensitivity assessment was undertaken exploring the application of earthworks over Lot 1 and 2 on Plan RP63783 and Lot 2 on RP48119 to inform the flood immunity of the lots across current and future developments.

Attachment B contains the engineering drawings of the reported stormwater assets.

3. Interim Developed Case

3.1. Basis of Design

The basis of design is to assess that the proposed stormwater measures, as part of the development of the PASK owned sites, satisfy the flood immunity requirements and Legal Point of Discharge Requirements as outlined in the Brisbane City Council City Plan (2014) and Queensland Urban Drainage Manual (2017).

3.2. Hydrologic Model

Hydrologic modelling undertaken as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FSMP01-V3) serves as the basis for this assessment for the Interim Developed Case (P05). The base case scenario hydrological model was modified, with the subcatchments containing the PASK owned developments modified to reflect the change in land-use. A summary of the catchment parameters is shown in Table 2-1, with a catchment plan shown in Figure 2-3.

TABLE 3-1: CATCHMENT PARAMETERS (INTERIM DEVELOPED CASE)

Sub-catchment	Downstream Sub-catchment	Area (ha)	Imperviousness (%)
A01	A03	4.822	2
A02	A03	2.751	3
A03	A05	3.020	0
A04	A06	3.260	0
A05	A06	3.577	8
A06	A07	3.117	1
A07	A08	4.015	1
A08	A16	4.319	39
A09	A10	3.281	70
A10	A14	2.387	70
A11	A12	2.371	35
A12	A16	2.023	70
A13	A14	2.109	42
A14	A20	0.841	58
A15	A19	3.200	0
A16	A19	3.219	22
A17	A19	2.044	0

Sub-catchment	Downstream Sub-catchment	Area (ha)	Imperviousness (%)
A18	A27	3.252	5
A19	A27	0.327	16
487RR	A20	4.218	75
A20	A21	0.927	38
A21	A27	0.264	58
ID07B	A27	6.336	5
STAGE11	A27	3.003	70
STAGE10	A27	3.231	70
STAGE9	A27	2.555	5
361RR	A28	3.636	70
A26	A27	2.290	11
A27	A28	1.933	3
A28	A29	1.553	0
A29	SINK	0.953	0

The WBNM parameters applied for this scenario are consistent with that applied as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FSMP01-V3). Modelling has been carried out for the 39%, 20%, 10%, 5%, 2% and 1% Annual Exceedance Probability (AEP) storm events. The inflows derived from the hydrological model were applied into the hydraulic model.

As requested by Brisbane City Council, a definitive assessment of the flood conditions downstream of the site are better informed using a hydraulic model. The proposed development has been prescriptively included in the Pinnacle at Arise hydraulic model (developed as part of 20-0102FSMP01-V3), for which a spatial assessment of the flood impacts has been undertaken for a range of design event magnitudes. This is discussed in detail in the following section.

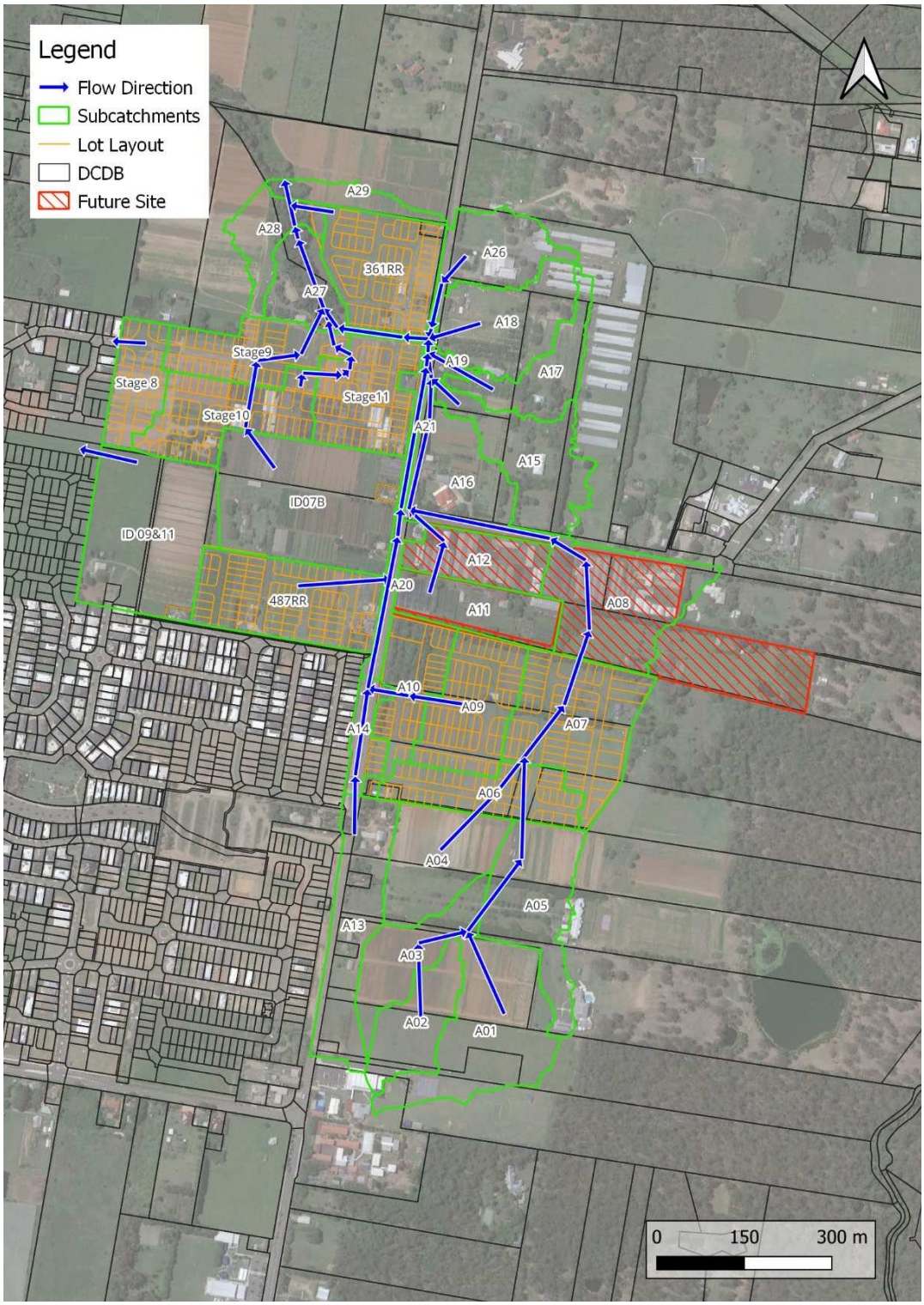


FIGURE 3-1: CATCHMENT PLAN (INTERIM DEVELOPED CASE)

3.3. Hydraulic Model

Hydraulic modelling has been carried out using TUFLOW software developed by BMT WBM in Brisbane. TUFLOW is a computational engine that provides one-dimensional (1D) and two-dimensional (2D) solutions for free-surface flow equations to simulate flood and tidal wave propagation.

Modelling assumptions and outcomes are described in the following sections.

3.3.1. Modelled Scenarios

A summary of the modelled scenarios is provided below:

- Base Case (E07a): The base case scenario developed as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FMSP01-V3) was adopted as the basis of assessment in which to assess the impacts of the development from of the site. A change from the original submission to the Base Case (E07a) is the extension of the model domain further north (in response to the information request from BCC) and delineation of the model boundary.

- Interim Developed Case (P05): This model has been developed to assess the impacts (if any) of the development. This modelling scenario applies the Interim Developed Case (P05) hydrologic modelling assumptions within the TUFLOW hydraulic model.

Modelling assumptions pertaining to the manning's (n) roughness, topography and hydraulic structures were adopted from the Base Case Scenario, outlined in Section 2.2 of the Pinnacle at Arise FSMP (20-102FMSP01-V3). The following modifications were applied to the model to represent the developments (PASK owned) and proposed stormwater measures.

3.3.2. Model Inflows

Model inflow polygons for the non-developed catchments are consistent with the Base Case Scenario (E07).

Model inflow polygons for the developed catchments have been informed by the stormwater network across the four developments and modelling applied as part of the Ultimate Developed Case (U09) as part of the Pinnacle at Arise FSMP (20-0102FMSP01-V3).

3.3.3. Model Topography

The base case model topography served as the basis for the Interim Developed Case, with the following topographic amendments, in the form of 2d_zsh files, applied:

- Digitisation of roadside channels (in the vicinity of 100 – 200 mm depth) along Rochedale Road and Ford Road.
- Formalizing an outlet channel for the trunk main.
- The conceptual earthworks for the development at 487 Rochedale Road (including the detention basin).

- Formalizing a bund (representing the elevated pad levels) along the southern boundary of 546 Rochedale Road (Pinnacle).

The following assets have been prescriptively included in the model as digital elevation model (DEM):

- The easement along the southern boundary of 361 Rochedale Road.
- The conceptual earthworks for each PASK owned development (excluding 487 Rochedale Road).
- The central spine road concept design.

3.3.4. Stormwater Drainage Network

The proposed stormwater network for the Interim Developed Scenario (P04) has been summarized in Table 2-2 and shown in Figure 2-3.

For the Interim Developed Scenario, a surcharge pit is proposed at the end of the trunk-line within Lot 4 on Plan RP183802. Connected to the surcharge pit is a bleeder pipe (M1A->Outlet), designed to route the minor flows to the drainage corridor to the west. It is intended that the surcharge pit and bleeder pipe be decommissioned upon the catchment being further developed (at the discretion of BCC), with an ultimate trunk pipe to be connected, routing flows to the drainage corridor.

For Arise Stage 8 -11, the basin outlet pipes (as reported in 18-1050SMP01-V3) and connector pipe routing flows from the upstream catchment (I07DB>MHS) have been represented in the model.

For 487 Rochedale Road, the basin outlet pipe, connected to the trunk line along Rochedale Road, has been represented in the model.

Flows generated upstream of the southern boundary of Pinnacle are to be directed to a field inlet and conveyed north by the internal stormwater network. The pit and pipe (underlying system) is designed to convey flows up to and including the 10% AEP storm event. The balance of the flows is to be conveyed north via kerb and channel.

TABLE 3-2: CULVERT DETAILS

Culvert ID	No.	Size/Type	USIL (m AHD)	DSIL (m AHD)	Approx. Length (m)	10% AEP Predicted Flow (m^3/s)
Basin_Major[1]	7	0.525m	62.71	62.60	20	1.506
Basin_Minor[1]	1	0.30m	62.41	61.20	~165	0.098
I07DB [1]	1	2.40m RCP	65.00	62.20	102	1.161
IN_S-> 6/1[2]	1	0.525m	68.00	67.60	48	0.784
C01	1	1.35m	77.25	75.55	84	1.613
C02	1	1.50m	75.45	71.20	195	2.862
C03	1	1.50m	71.10	68.20	157	4.311
C04	1	1.80m	68.18	67.65	45	5.557

Culvert ID	No.	Size/Type	USIL (m AHD)	DSIL (m AHD)	Approx. Length (m)	10% AEP Predicted Flow (m^3/s)
C05	1	1.95m	67.60	65.80	253	5.533
C06	1	2.10m	65.70	65.25	40	6.477
C07	1	2.10m	65.20	65.10	7	6.456
4/1->3/1	1	2.40 m	65.00	64.05	100	9.161
3/1->2/1	1	2.40 m	64.00	63.45	75	9.157
2/1->1/1	1	2.40 m	63.30	62.00	129	9.151
1/1->M1A	1	2.40 m	62.00	61.67	23	9.144
M1A->Outlet[3]	1	0.60 m	61.67	60.82	159	9.144
A12	1	0.90m	67.00	66.80	7	1.632

[1]relating to Arise Stage 8-11 (18-1050SMP01-V3)

[2]relating to 487 Rochedale Road (19-0154FSMP01-V1)

[3]temporary stormwater pipe, to be decommissioned once 'ultimate' drainage solution is activated.

3.3.5. Model Boundary

The model domain (2d_code) was extended further north, along with the model boundary. This allows for flows along the northern boundary to circulate effectively (mitigation of the 'glass-wall' effect) in the model and informs the magnitude and extent of flooding along the northern boundary of 361 Rochedale Road.

3.3.6. Roughness

Roughness values have been adjusted to reflect the development works within the flow path and development (refer to Figure 2-2).

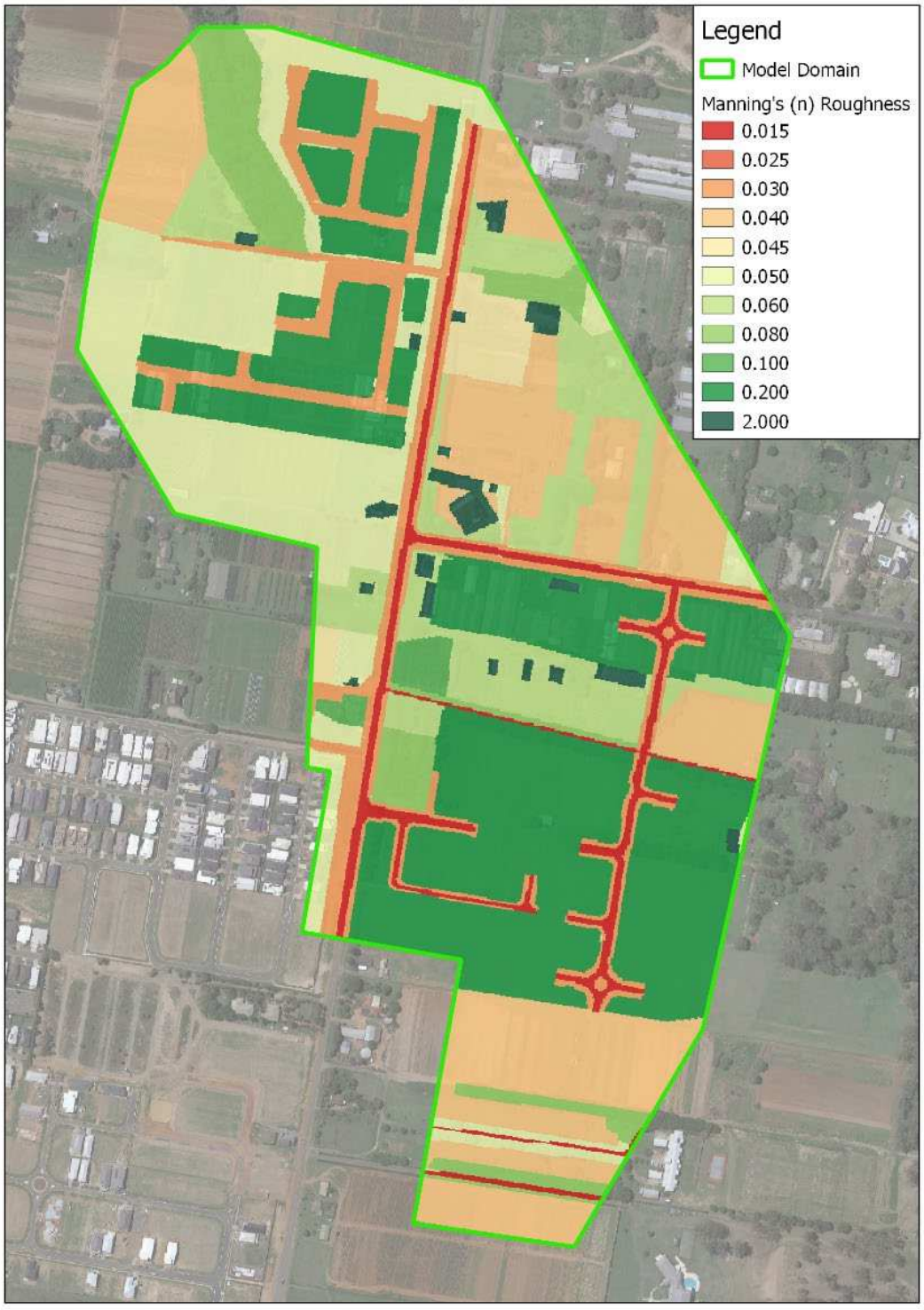


FIGURE 3-2: MANNING'S ROUGHNESS DELINEATION

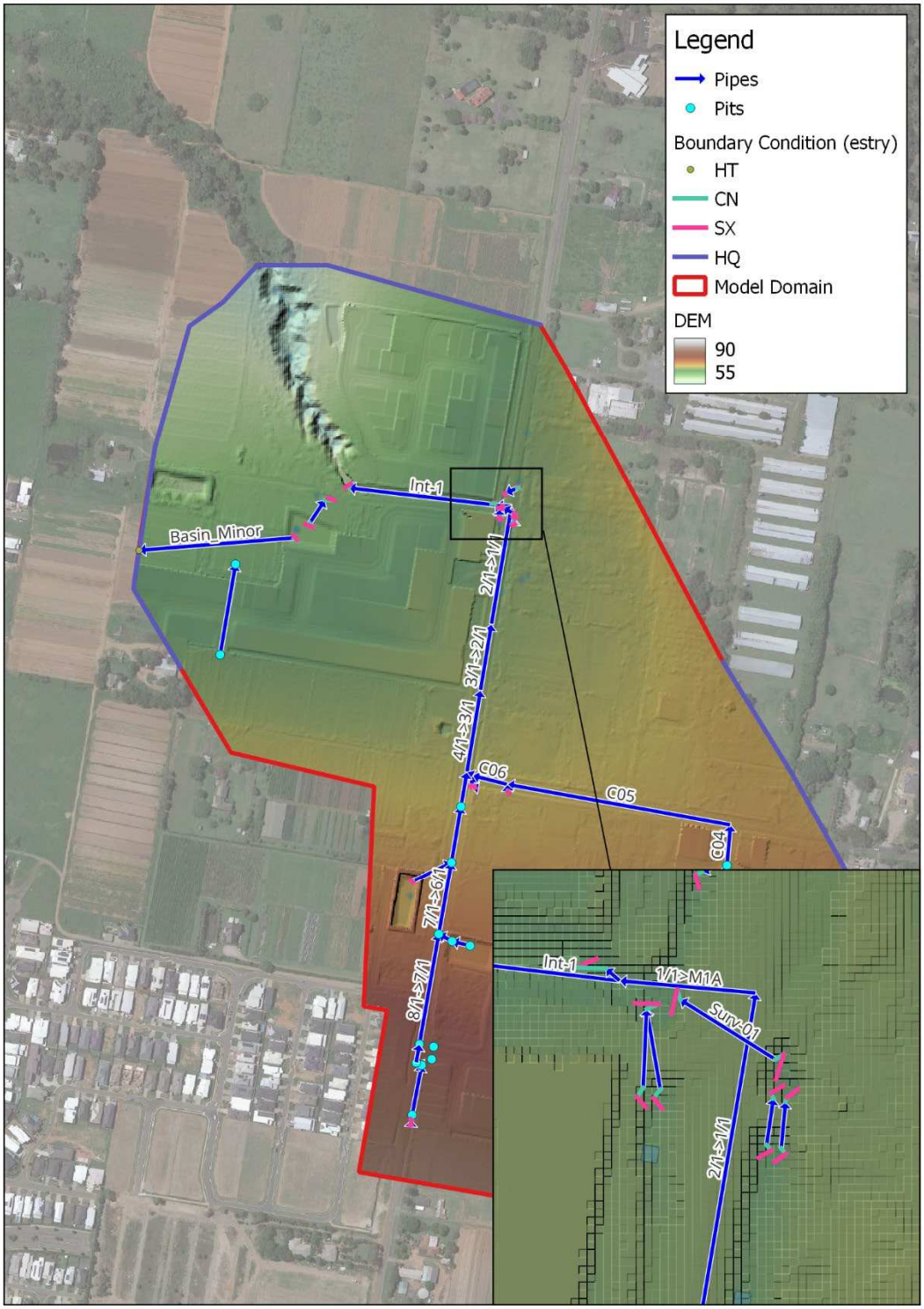


FIGURE 3-3: MODEL DEVELOPMENT (INTERIM DEVELOPED CASE)

3.3.7. Model Results

The TUFLOW hydraulic models, as discussed above, have been assessed for a range of flood events from the 39% to the 1% AEP storm events. The assessment has considered a range of design storms to ensure that the critical storm is defined. The results of the hydraulic assessment are presented as a series of flood maps to illustrate the flooding characteristics of all the development scenarios and their resulting flood behaviours including flooded depth, velocities, hazard, and afflux.

3.3.7.1. Results – Base Case Scenario (E07a)

The existing scenario flood maps are contained in **Appendix E** of the Pinnacle at Arise FSMP (20-0102FSMP01-V3). This details the existing flood extent and behaviour of the catchment. The results of this have been used as the basis for assessing the potential impacts that may result from the proposed developments.

3.3.7.2. Results – Interim Developed Case (P05)

The Interim Developed Case modelling results are shown in the series of flood maps in **Attachment C**. The flood maps have demonstrated that the proposed stormwater measures have no negative impacts on the building footprints of surrounding properties, with impacts limited to the overland flow planning area. It is shown that there are reductions in the flood extent and afflux across nearly all properties north of Ford Road, with no concerning velocity fluctuations.

Flows from the surcharge pit are effectively dissipated, with the balance of the flows adequately conveyed through the easement, prior to discharging into the drainage corridor, with the driveway serving Lot 2 on Plan RP115631 trafficable up to and including the major storm event. The predicted flows in the bleeder pipe and temporary easement are shown in Table X across all assessed storm events.

TABLE 3-3: PEAK FLOWS THROUGH TEMPORARY EASEMENT AND BLEEDER PIPE

AEP	Critical Duration (min)	Bleeder Pipe Peak Flows (m^3/s)	Temporary Easement Peak Flows (m^3/s)
39%	60	1.00	6.99
20%	60	1.00	9.33
10%	60	1.00	10.66
5%	60	1.00	12.37
2%	60	1.00	13.67
1%	60	1.00	14.31

Outflows from the basin serving Arise Stages 8 – 11 are effectively conveyed through Lot 2 on RP115631to the drainage corridor, without generating afflux in the major storm events (from the 5% AEP event through to and including the 1% AEP storm event). In the modelled events less than 5% AEP the interim measures effectively reduce flows towards the dwelling located on Lot 2 RP115631 and direct flows towards the waterway. This does result in a minor redistribution of flows across the boundary but afflux is limited to areas already impacted by flood in the existing case and are limited to less than 40 mm. It would be possible to resolve the afflux if necessary however this would require the spreading of flow towards the downstream residence. It was considered this would be a less preferred alternative.

3.3.7.3. Pinnacle Southern Boundary Lot Immunity

The model has been modified to include inflows upstream of the southern boundary of Pinnacle. The modelling has determined a minimum fill level over the lots along the southern boundary of The Pinnacle at Arise Stage 8 to ensure immunity, with the peak water level predicted to rise to 80.25 m AHD. The pad levels of the lots along the southern boundary are to be raised above the predicted 1% AEP flood level to maintain flood immunity (or to 80.3 m AHD). Overland flow is to be directed toward the road, with minor flows (up to and including the 10% AEP event) to be collected by the pit inlet, with the difference of flows to be routed via kerb and channel north.

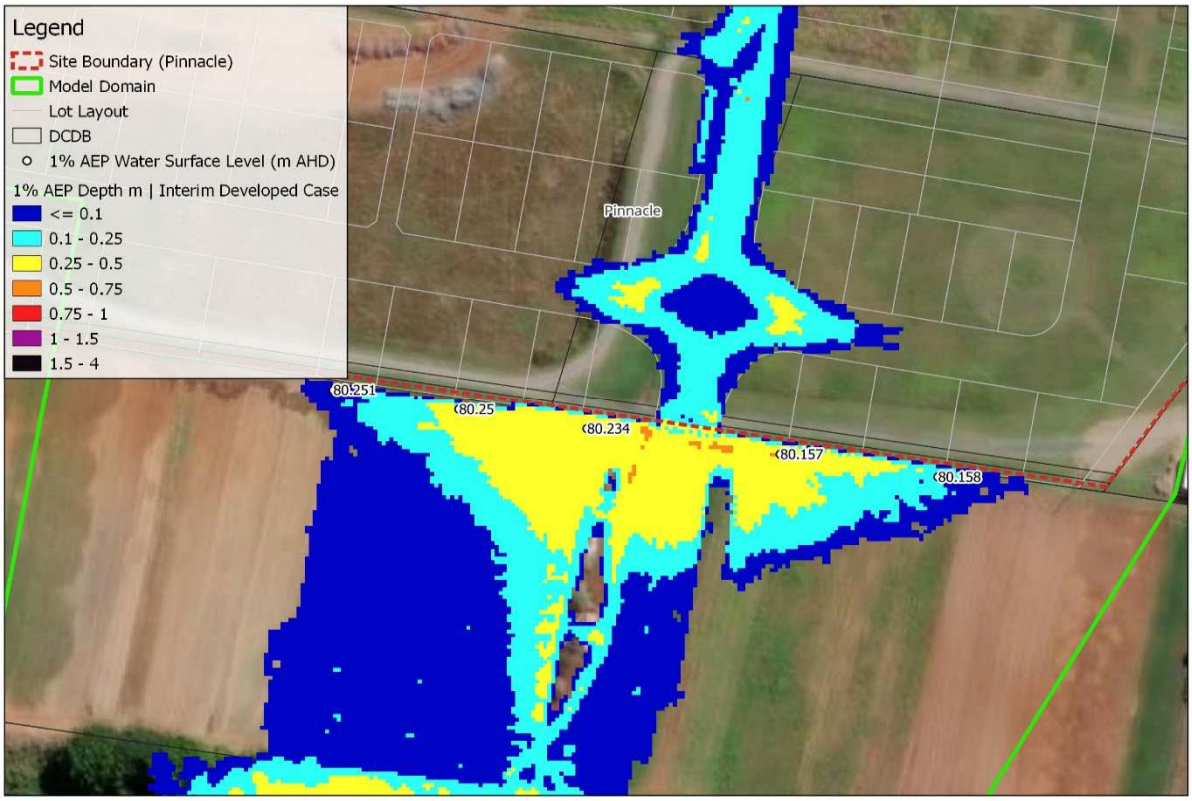


FIGURE 3-4: INTERIM PEAK FLOOD LEVELS AT SOUTHERN BOUNDARY OF PINNACLE

It is noted that in this interim scenario it is predicted that localised increases in the predicted peak flood level are expected in the areas immediately upstream (south) of the development boundary. These increases are generally limited to areas of predevelopment inundation and are not predicted to impact any structures or access within the adjoining property. The predicted increase in peak flood levels are not assessed to be of a nature that would amount to nuisance or result in damage to the upstream property under this interim condition.

4. Ultimate Developed Case

4.1. Basis of Design

The basis of design is to assess that the proposed pad levels (as part of the PASK developments) satisfy flood immunity requirements. This scenario assumes a fully developed catchment and trunk infrastructure through to the drainage corridor.

4.2. Hydrologic Model

Hydrologic modelling undertaken as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FSMP01-V3) serves as the basis for this assessment for the Ultimate Developed Case (U10). The ultimate developed case scenario hydrological model (U09) was modified to be consistent in terms of the number of catchments and catchment delineation, with the percentage imperviousness updated to reflect the change in land use in subcatchments. A summary of the catchment parameters, for the subcatchments that have been manipulated as part of this assessment, is shown in Table 3-1, with a catchment plan shown in Figure 3-1.

TABLE 4-1: CATCHMENT PARAMETERS (INTERIM DEVELOPED CASE)

Sub-catchment	Downstream Sub-catchment	Area (ha)	P04 Imperviousness (%)	U10 Imperviousness (%)	Change in Imperviousness (U10-P04)
A01	A03	4.822	2	70	68
A02	A03	2.751	3	70	67
A03	A05	3.020	0	70	70
A04	A06	3.260	0	70	70
A05	A06	3.577	8	70	62
A06	A07	3.117	1	70	69
A07	A08	4.015	1	70	69
A08	A16	4.319	39	70	31
A09	A10	3.281	70	70	0
A10	A14	2.387	70	70	0
A11	A12	2.371	35	70	35
A12	A16	2.023	70	70	0
A13	A14	2.109	42	70	28
A14	A20	0.841	58	70	12
A15	A19	3.200	0	70	70

Sub-catchment	Downstream Sub-catchment	Area (ha)	P04 Imperviousness (%)	U10 Imperviousness (%)	Change in Imperviousness (U10-P04)
A16	A19	3.219	22	68	46
A17	A19	2.044	70	70	70
A18	A27	3.252	70	70	65
A19	A27	0.327	68	68	52
487RR	A20	4.218	75	75	0
A20	A21	0.927	38	70	32
A21	A27	0.264	58	70	2
ID07B	A27	6.336	5	5	0
STAGE11	A27	3.003	70	70	0
STAGE10	A27	3.231	70	70	0
STAGE9	A27	2.555	5	5	0
361RR	A28	3.636	70	70	0
A26	A27	2.290	11	69	58
A27	A28	1.933	3	3	0
A28	A29	1.553	0	0	0
A29	SINK	0.953	0	0	0

The WBNM parameters applied for this scenario are consistent with that applied as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FSMP01-V3). Modelling has been carried out for the 39%, 20%, 10%, 5%, 2% and 1% Annual Exceedance Probability (AEP) storm events. The inflows derived from the hydrological model were applied into the hydraulic model.

As requested by Brisbane City Council, a definitive assessment of the flood conditions downstream of the site are better informed using a hydraulic model. The proposed development has been prescriptively included in the Pinnacle at Arise hydraulic model (developed as part of 20-0102FSMP01-V3), for which a spatial assessment of the flood impacts has been undertaken for a range of design event magnitudes. This is discussed in detail in the following section.

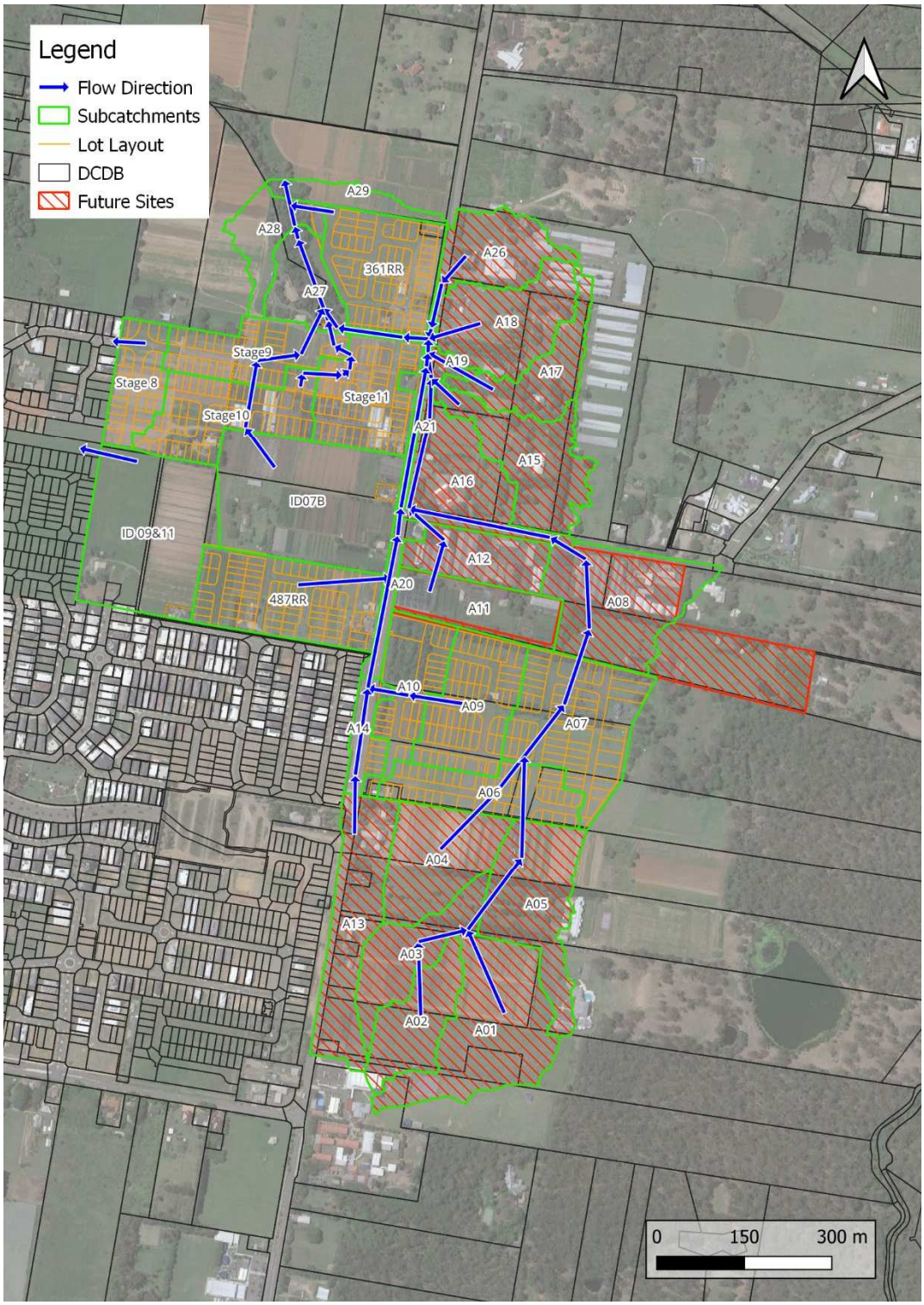


FIGURE 4-1: CATCHMENT PLAN (ULTIMATE DEVELOPED CASE)

4.3. Hydraulic Model

Hydraulic modelling has been carried out using TUFLOW software developed by BMT WBM in Brisbane. TUFLOW is a computational engine that provides one-dimensional (1D) and two-dimensional (2D) solutions for free-surface flow equations to simulate flood and tidal wave propagation.

Modelling assumptions and outcomes are described in the following sections.

4.3.1. Modelled Scenarios

A summary of the modelled scenarios is provided below:

- Base Case (E07a): The existing case scenario developed as part of the Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FMSP01-V3) was adopted as the basis of assessment in which to assess the impacts of the development from of the site. A change from the original submission to the Base Case (E07a) is the extension of the model domain and delineation of the model boundary.

- Ultimate Developed Case (U10): This model has been developed to assess the impacts (if any) of the development. This modelling scenario applies the Ultimate Developed Case (U10) hydrologic modelling assumptions within the TUFLOW hydraulic model.

- Ultimate Developed Case (U10ss) with consideration to future earthworks: This model has been developed to assess the flood immunity of Rochedale and Ford Road, with conceptual earthworks applied across Lots 1 &2 on Plan RP63783 and Lot 2 on Plan RP48119. This modelling scenario applies the Ultimate Developed Case (U10) hydrologic modelling assumptions.

Modelling assumptions pertaining to the manning's (n) roughness, topography and hydraulic structures were adopted from the Ultimate Developed Case Scenario (U09), outlined in Section 2.2 of the Pinnacle at Arise FSMP (20-102FMSP01-V3). The following modifications were applied to the model to represent the development(s) and proposed stormwater measures.

4.3.2. Model Inflows

Model inflow polygons for the non-developed catchments are consistent with the Base Case Scenario (E07).

Model inflow polygons for the developed catchments have been informed by the stormwater network and assets across the four developments and modelling applied as part of the Ultimate Developed Case (U09) as part of the Pinnacle at Arise FSMP (20-0102FMSP01-V3).

4.3.3. Model Topography

The Ultimate Developed Case (U09) model topography served as the basis for the Ultimate Developed Case, with the following topographic amendments, in the form of 2d_zsh files, applied:

- The conceptual earthworks for the development at 487 Rochedale Road (including the detention basin).

The following assets have been prescriptively included in the model as digital elevation model (DEM):

- The easement along the southern boundary of 361 Rochedale Road.
- The conceptual earthworks for each PASK owned development (excluding 487 Rochedale Road).
- The central spine road concept design has been included in the model as a digital elevation model (.dem).

4.3.4. Stormwater Drainage Network

The proposed stormwater network for the Ultimate Developed Scenario (U10) has been summarized in Table 3-2 and shown in Figure 3-2.

For the Ultimate Developed Scenario, the surcharge pit and bleeder pipe is decommissioned, with the trunk-line to be extended to the drainage corridor to the west (represented by culvert ID Ult-1).

For Arise Stage 8 -11, the basin outlet pipes (as reported in 18-0150SMP01-V3) and connector pipe routing flows from the upstream catchment (I07DB>MHS) have been represented in the model. For 487 Rochedale Road, the basin outlet pipe, connected to the trunk line along Rochedale Road, has been represented in the model.

TABLE 4-2: CULVERT DETAILS

Culvert ID	No.	Size/Type	USIL (m AHD)	DSIL (m AHD)	Approx. Length (m)	10% AEP Predicted Flow (m^3/s)
Basin_Major[1]	7	0.525m RCP	62.71	62.60	20	0.098
Basin_Minor[1]	1	0.30m RCP	62.41	61.20	~175	1.51
I07DB>MHS[1]	1	2.40m RCP	65.00	62.20	102	2.10
IN_S-> 6/1[2]	1	0.525m RCP	68.00	67.60	48	0.77
C01	1	1.35m RCP	77.25	75.55	84	3.60
C02	1	1.50m RCP	75.45	71.20	195	4.50
C03	1	1.50m RCP	71.10	68.20	157	6.32
C04	1	1.80m RCP	68.18	67.65	45	8.06
C05	1	1.95m RCP	67.60	65.80	253	8.04
C06	1	2.10m RCP	65.70	65.25	40	9.50
C07	1	2.10m RCP	65.20	65.10	7	9.40
9/1->8/1	1	0.825 m RCP	76.07	74.97	32	1.44
8/1->7/1	1	0.825 m RCP	74.95	70.63	120	1.94

Culvert ID	No.	Size/Type	USIL (m AHD)	DSIL (m AHD)	Approx. Length (m)	10% AEP Predicted Flow (m^3/s)
7/1->6/1	1	1.05 m RCP	70.14	67.61	84	3.01
6/1->5/1	1	1.2 m RCP	67.46	66.09	62	3.55
5/1->4/1	1	1.2 m RCP	66.07	65.77	30	3.64
4/1->3/1	1	2.40 m RCP	65.00	64.05	100	12.98
3/1->2/1	1	2.40 m RCP	64.00	63.45	75	12.99
2/1->1/1	1	2.40 m RCP	63.30	62.00	129	13.97
1/1->1/1A	1	2.40 m RCP	61.20	61.02	7	17.99
Ult-1	1	2.40 m RCP	61.00	60.00	172	18.09
A12	1	0.90m RCP	67.00	66.80	7	1.54
A16	1	0.75m RCP	64.50	64.45	20	1.18
A19	1	1.20m RCP	62.40	62.30	15	3.59
A26	1	0.75m RCP	63.50	63.00	78	0.89

[1]relating to Arise Stage 8-11 (18-1050SMP01-V3) [2]relating to 487 Rochedale Road (19-0154FSMP01-V1)

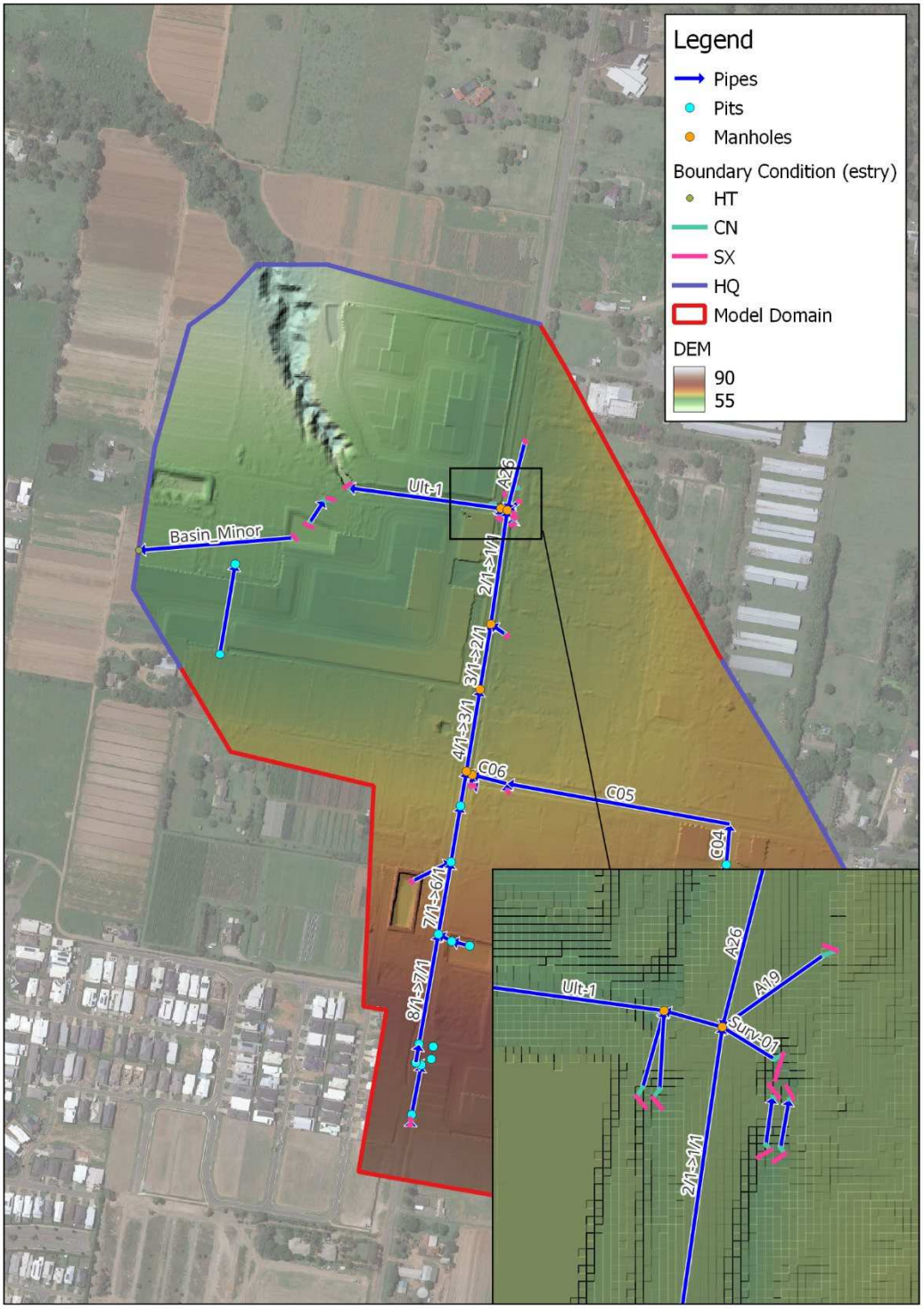


FIGURE 4-2: MODEL DEVELOPMENT (ULTIMATE)

4.3.5. Model Boundary

The model domain (2d_code) was extended further north, along with the model boundary. This allows for flows to resolve effectively within the model space and informs the extent of flooding along the northern boundary of 387 Rochedale Road.

4.3.6. Model Results

The TUFLOW hydraulic models, as discussed above, have been assessed for a range of flood events from the 39% to 1% AEP storm events. The assessment has considered a range of design storms to ensure that the critical storm is defined. The results of the hydraulic assessment are presented as a series of flood maps to illustrate the flooding characteristics of all the development scenarios and their resulting flood behaviours including flooded depth, velocities, hazard, and afflux. The flood maps are contained in Appendix **Attachment D**.

The flood maps have demonstrated that the proposed stormwater measures have no negative impacts on the building footprints of surrounding properties, with impacts limited to the overland flow planning area. It is shown that there are reductions in flood extent and afflux across nearly all properties north of Ford Road, with no concerning velocity fluctuations.

The stormwater network adopted within this design scenario provides suitable preliminary sizing for the ultimate trunk infrastructure to the drainage corridor (located at Lot 4 on Plan RP183802). This is demonstrated in the 10% AEP flood maps, with no overland by-pass flows predicted. For the major events (greater than the 10% AEP event), the road network satisfies QUDM's 'major' flow design requirements, being:

- Maximum depth of flow < 250mm (refer to the **Attachment D**) and
- Maximum flood hazard < 0.6m^2/s.

The proposed pad levels satisfy flood immunity requirements, with adequate freeboard maintained along the drainage corridor and trunk line.

It is noted that for the purposes of this exercise the Interim arrangement for the basin serving Arise Stages 8 – 11 has been maintained. Once the trunk pipe is able to be extended through to the waterway, there will be opportunity to remove the interim basin and extend discharge form the site through to the waterway directly. However, the modelled case is considered to be the worst case scenario and future removal and upgrade of the discharge conditions from Stages 8-11 will not alter the outcomes of this modelling.

4.3.6.1. Results - Ultimate Developed Case (U10ss) with Consideration of Future Earthworks

In response to an information request item from BCC, another version of the ultimate scenario was developed to inform the flood immunity and trafficability along Rochedale and Ford Road, with conceptual earthworks (in the form of 2d_zsh polygon layer) applied across Lots 1 &2 on Plan RP63783 and Lot 2 on

Plan RP48119. The modelling indicated that Rochedale and Ford Road are considered trafficable in accordance with QUDM, and the lots encompassing the road boundary are deemed immune to flooding.

5. Conclusion

Hydrological and hydraulic analysis indicates that the two stages of developments – Interim Developed (PASK sites only) and Fully Developed (beyond PASK sites) and pertinent stormwater measures - satisfy the flooding and immunity requirements as outlined in the Brisbane City Council City Plan (2014) and Queensland Urban Drainage Manual (2017).

6. Disclaimer

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Attachments

Attachment A	Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FSMP01-V3)
Attachment B	Concept Design & Engineering Drawings (Interim Developed Case)
Attachment C	Interim Developed Case Flood Maps
Attachment D	Ultimate Developed Case Flood Maps

Attachments

Attachment A Pinnacle at Arise Flooding and Stormwater Management Plan (20-102FSMP01-V3)

Available on request. Not included due to file size.